THE SOUTHERN KIANG *EQUUS KIANG POLYODON*

(*With six text-figures and two plates*)

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Key words: *Equus kiang polyodon*, skull data, morphology, distribution, threats, north Sikkim, south Tibet

The Tibetan wild ass or kiang can be divided into 3 subspecies: the Eastern kiang (*Equus kiang holdereri*), the Western kiang (*E.k. kiang*) and the Southern kiang (*E.k. polyodon*). So far, the Southern kiang was only briefly known, mainly from sparse and inconsistent material, based on Hodgson's 19th century collection in the British Museum. Now additional skulls of *polyodon*, collected in north Sikkim in 1938/39 by the expedition of E. Schaefer, have been discovered in the Zoological Museum in Berlin and for the first time examined by the authors. The data prove that the Southern kiang is indeed a separate subspecies with shorter, but relatively broader and more box-shaped head. Mounted specimens show differences in colouration and about 10-20% lower withers height than other kiangs. All available sightings of kiangs south of latitude 32° N since 1774, were brought together, analysed, locations determined and the extensive data used to draw a sound new kiang distribution map for Sikkim, Nepal and south Tibet. The distribution boundaries and populations of the Southern kiang, especially towards the west, need further investigation. Possibly there are not more than a few hundred Southern kiangs left, making it an endangered subspecies, which urgently requires more attention. Only better knowledge can help to protect the smallest kiang and its habitat adequately.

INTRODUCTION

The kiang or Tibetan wild ass has been regarded by some authors as a distinct species (*Equus kiang*), while others regard it as a subspecies of *Equus hemionus*. Even modern molecular genetic studies have not led to any agreement. While Groves and Ryder (2000) stand for the separation as a species, Schreiber (pers. comm. in 2002) suggests keeping the question open till data for its closest relative, the dziggetai (*Equus hemionus hemionus*), are available for comparison. Eisenmann (1986) is unable to discriminate between skulls belonging to dziggetai (*E.h. hemionus*) and kiang, so that she is tempted to consider the kiang as a subspecies of *Equus hemionus*. After examining a larger database (160 skulls: 35 kiangs, 29 dziggetais, 32 kulans, 37 onagers and 27 khurs), she concludes in Schreiber *et al.* (2000) that "the present osteological database supports a single-species concept for all other hemiones" (other than *hemippes*, which were omitted from discussions). One of the reasons for regarding the kiangs as subspecies of *Equus hemionus* is that the offspring of a male hybrid (kulan x kiang) and a female kulan proved to be fertile (Pohle 1983, 1986). This argument, according to clarification in Groves and Ryder (2000), is not valid.

We want to review the available data and add some new skull data as well as geographical locations regarding the poorly known southern subspecies of the kiang (*E. kiang polyodon* respective *E. hemionus polyodon*). Since the discovery and description of the Southern kiang was accompanied by several historical errors, it is necessary to explain some details of the relevant publications chronologically.

HISTORY

Early material: After a brief description of a dead specimen along with the first naming for

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Equus kiang by Moorcroft (1824) and another more detailed description of the same specimen by Moorcroft and Trebeck (1841), Hodgson (1842) postulated that a second wild member of the horse family existed in Tibet, which he believed at that time to be neither identical with the kiang of Moorcroft nor the hemione (of Pallas) but with the *Asinus*: "*Asinus equioides*, Mihi. Species wants verification, spoken of by Moorcroft and others". In fact, Moorcroft had earlier mentioned sightings of wild horses, wild asses, as well as hybrids of both, on his first visit into Tibet in 1812 (Gupta 1987). Some years later Hodgson (1847a), after obtaining some kiang specimens for examination, described these animals under the genus *Equus*, sub-genus *Asinus*, as "*Asinus polyodon mihi*," with the remarks, "very common in all parts of Tibet," and, "there is, I believe, no species of wild horse in Tibet, and only one species of wild ass, *viz.* the kiang above described ... I think the kiang may prove a new species, and I have named it *polyodon* from its singularly anomalous dentition, having 7.7 molars in the upper jaw." In a drawing of a skull and a row of upper cheek teeth, he pointed to the location of the additional tooth (today known as wolf tooth).

Hodgson (1847a) mentioned five kiangs (not clear if complete specimens or just skins), one kiang skull and later two fresh kiang specimens (provided with skulls) at his disposal. He published dimensions of a male and a female kiang, and data of a female kiang skull (all in comparison with a tanghan or Tibetan pony), but without informing the reader where exactly his kiang specimens came from (subtitle of his attached Plate 6: "*Asinus polyodon mihi.* The kiang of East Tibet"), as in those days only one kind of kiang was believed to exist all over the high altitude region.

After having received comments regarding similar dental anomalies among other equids, Hodgson (1847b) compared the teeth of three kiang skulls (all young, but no one less than 4 years old) with those of domestic horses and concluded: "That they have done so (highest authorities had uniformly given 6/6 for the Equine formula) is a fact sufficient to excuse and justify my insisting on the extra tooth commonly found in the kiang, and not, I believe, commonly found in the *Equus*."

Gray (1849) received three kiang specimens sent by Hodgson to the British Museum: "unfortunately they were so destroyed by insects during their passage from India, that it was impossible to preserve any part of them except the skull and the bones of the limbs." He described three skulls, but referred to them first (1849) as *Equus kiang*, and later (1852) as *Asinus hemionus* and *Asinus kiang*. He obviously faced a problem in placing the kiang among the equids.

In the Catalogue of the British Museum (Gray 1852, p. 273), the three kiang skulls presented by Hodgson are inadequately marked as "two skulls, lower jaw wanting." A scaled drawing of a skull (not the same as in Hodgson 1847a) is shown in Gray's Fig. 2 in Table 37.

The two special catalogues of Hodgson's collection presented to the British Museum (Gray 1846, 1863) do not mention any kiang skull, only a kiang skin (presented in 1858). However, skulls of two tanghans and another domestic equid (listed as "mule of Tibet" or "*Equus caballus* var. *domestica*") also from 1858, are mentioned. Before the second catalogue of Hodgson's collection was published by Gray in 1863, Gerrard (1862) had already published another catalogue in which he misidentified the two tanghan skulls and listed them as kiangs. This error caused confusion regarding the identity of the Southern kiang, for over a century, as even Lydekker (1916) repeated it.

Lydekker (1916) listed, in his catalogue of the ungulate mammals in the British Museum (BM), five kiang skulls presented by Hodgson to the Museum between 1848 and 1858. Three skulls from 1848 were numbered as 48.6.11.16(976a), 48.6.11.17(976b) and 48.6.11.18(976c); and two from 1858, as 58.6.24.119(976h) skull and skin, and

58.9.24.150(976g). For the 1848 skulls, Lydekker gave the locality as "probably Hundes district of Tibet", and for the 1858 animals, "upper Sikhim." Another kiang skull and skin in Lydekker's catalogue, BM79.11.21.182(976j), transferred from the Indian Museum in 1879, are also connected with Hodgson's name and with the doubtful locality "Hundes?". In 1891, a skin (and skull, the latter not mentioned by Lydekker) collected by Mandelli from Sikkim, were given the number 91.10.7.176. Lydekker described all kiangs as "*Equus kiang*."

One has to take into account (see Hunter 1896) that Hodgson collected huge amounts of zoological material from Nepal and Tibet during his time at Kathmandu (1825-1843) and later during 1845-1858 from Darjeeling (in those days part of Sikkim), and presented the collections to the British Museum. L. Mandelli was a tea planter and ornithologist in Darjeeling.

Introduction of the southern subspecies: Trumler (1959) was the first to notice a difference between some of the skulls of Hodgson's BM collection and other kiang skulls of western or eastern race, and named a new subspecies which he called *Equus kiang nepalensis*, unfortunately using 58.6.24.119 as holotype and 58.6.24.150 as paratype. Groves and Mazák (1967) investigated the skulls of the Hodgson collection from 1858 again, and concluded that Trumler's holotype and paratype belong to horses (Tibetan ponies/ tanghan). When we checked the old catalogues it became evident that Gerrard (1862) and Lydekker (1916) had listed the tanghan skulls presented by Hodgson (Gray 1863) erroneously as kiang skulls, and Gerrard's location "Nepal" and Lydekker's location "Upper Sikhim" were unproven speculations. But the exact origin of Hodgson's true kiang material still remained unknown. Gerrard mentioned "Thibet" and Lydekker, "probably Hundes." Groves and Mazák (1967) believed that it came "most likely from the area of Tibet north of the Sikkhim border", while the skull 91.10.7.176 (Mandelli coll.) is doubtless from Sikkim. Groves and Mazák (1967) named the Southern kiang as *Asinus kiang polyodon* Hodgson, 1847.

Eisenmann and Shah (1996) also did not believe that certain equid skulls of Trumler's study belonged to kiangs at all. They wrote that "the skulls labelled *Kiang nepalensis trumler* in the British Museum collection (never trust a label!)" are those of *E. caballus*.

Southern Kiang Material in Various Museums

London: 4 skulls (1 ♂, 3 ♀) and 2 skins of Hodgson's collection (dated 1848, 1858 and 1879); and 1 skin and 1 skull (♂), partly broken, collected by Mandelli in 1891.

Calcutta (=Kolkata): A kiang skull forwarded in 1838 by G.T. Lushington to the Indian Museum in Calcutta (Blyth 1863, origin: Tibet) could perhaps also belong to the southern subspecies, as the basilar length of this adult specimen is only 425 mm (our measurement), although its exact origin and history is unknown.

Blyth (1863) also mentioned 3 kiang skins presented to the museum in Calcutta by Dr. Archibald Campbell, 2 of them (mare and foal) mounted. Dr. Campbell, the Superintendent of Darjeeling, joined J.D. Hooker on one of his journeys (1848-1849) to Sikkim and south Tibet. It can only be speculated that he obtained the kiangs from the range of the southern subspecies. While searching for details, we found the following remark in Campbell's Diary (Campbell 1852), dated October 25, 1849, Lachoong: "We purchased three good skins of the kiang of Thibet to-day, a male, female, and young one, and sent them to Doctor O'Shaughnessy at Darjeeling for the Asiatic Society's Museum. The men who sold them were Thibetan hunters. People who live by hunting in Thibet are called 'Hurpo'; they are very numerous; they eat the kiang, and all other animals, use the gun, make their own powder, and are good marksmen; they cultivate and graze sheep occasionally; but live mostly by the chase." The place Lachoong (=Lachung, 27.7° N, 88.7° E) is

located in Sikkim, about 30 km off the Southern kiang's distribution boundary. From these lines in Campbell's Diary we come to know that he did not hunt kiangs himself, but bought them. This, perhaps, allows us to draw the conclusion, that the kiang specimens in Hodgson's collection, some of them definitely known to be procured by Dr. Campbell as well, were also purchased at markets or from hunters in Sikkim, without knowing the exact locality.

Leiden: The catalogues of Jentink (1887, 1892) mention a skull of an adult individual *Equus hemionus* from Tibet (coll. M. Hodgson, 1853), as well as a mounted adult male *Equus asinus kiang* from Ladakh, Tibet (coll. M. Hodgson). The location Ladakh is obviously wrong. This skull, No. R1666A, has a greatest length of 501.5 mm (our measurement).

Frankfurt: At the same time as Leiden, the Senckenberg Museum obtained a kiang specimen of Hodgson's 1853 collection, from London [according to old correspondence between Horsfield and Temminck, investigated by Smeenk (pers. comm. in 2002)]. According to Kock (pers. comm. 2002), there is a skull in the Senckenberg Museum, without history, which could fit, but it was not accessible for examination due to renovations in the building.

Berlin: Ernst Schaefer went on his 1st and 2nd Tibet expeditions (1931-32 and 1934-36) as a member of the American Brooke Dolan Tibet Expeditions (Academy of Natural Science, Philadelphia). Only the 2nd expedition had collected Eastern kiangs in east and central Tibet for museum collections and also for the Zoological Museum in Berlin (ZMB).

The 3rd Tibet expedition of Ernst Schaefer went to Sikkim and south Tibet in the years 1938-39. According to museum documents we studied in Berlin (Schaefer SIII), a total of 15 kiangs were collected in northern Sikkim and given to the museum. One kiang was shot on July 28, 1938 at Gyakang, the other 14 kiangs were shot to the east of Lake Gaymtsona So between August 12-24, 1938, and on October 1, 1938. So, the origin of these specimens is well known. According to the actual filing cards, besides the 15 skulls, the museum has 7 skins of Southern kiangs (although the correspondence in Schaefer SIII mentioned 15 skins). For the identity of a mounted group of 3 kiangs see the section on Morphology.

Skull Data

Measurements: Out of the 15 skulls of Schaefer's collection, 14 were examined by us in ZMB, the 15th (unsexed juvenile ZMB 70291) was totally broken. All skulls were measured, but for this study we only used the data of the 7 adult specimens having six fully developed cheek teeth, i.e. 4 males with numbers ZMB 91104, 91106 (Plate 1, Fig. 1), 91107, 83377, and 3 females with numbers 91108, 91110, 83379. The juvenile skull numbers are: male 91105, 91117, female 83378, 83380, 91109, 91111, 91116.

To allow comparisons with data of other kiangs, we used here the same measurements as published by Groves and Mazák (1967) (Table 1). Groves and Mazák (1967) used, besides the 5 Southern kiang skulls of the British Museum, two skulls (ZMB 91106 and 91110) from Berlin (Groves, pers. comm. in 2002). This means that two skulls of Schaefer's collection were available in ZMB at that time. The others remained — for reasons unknown — undetected so far.

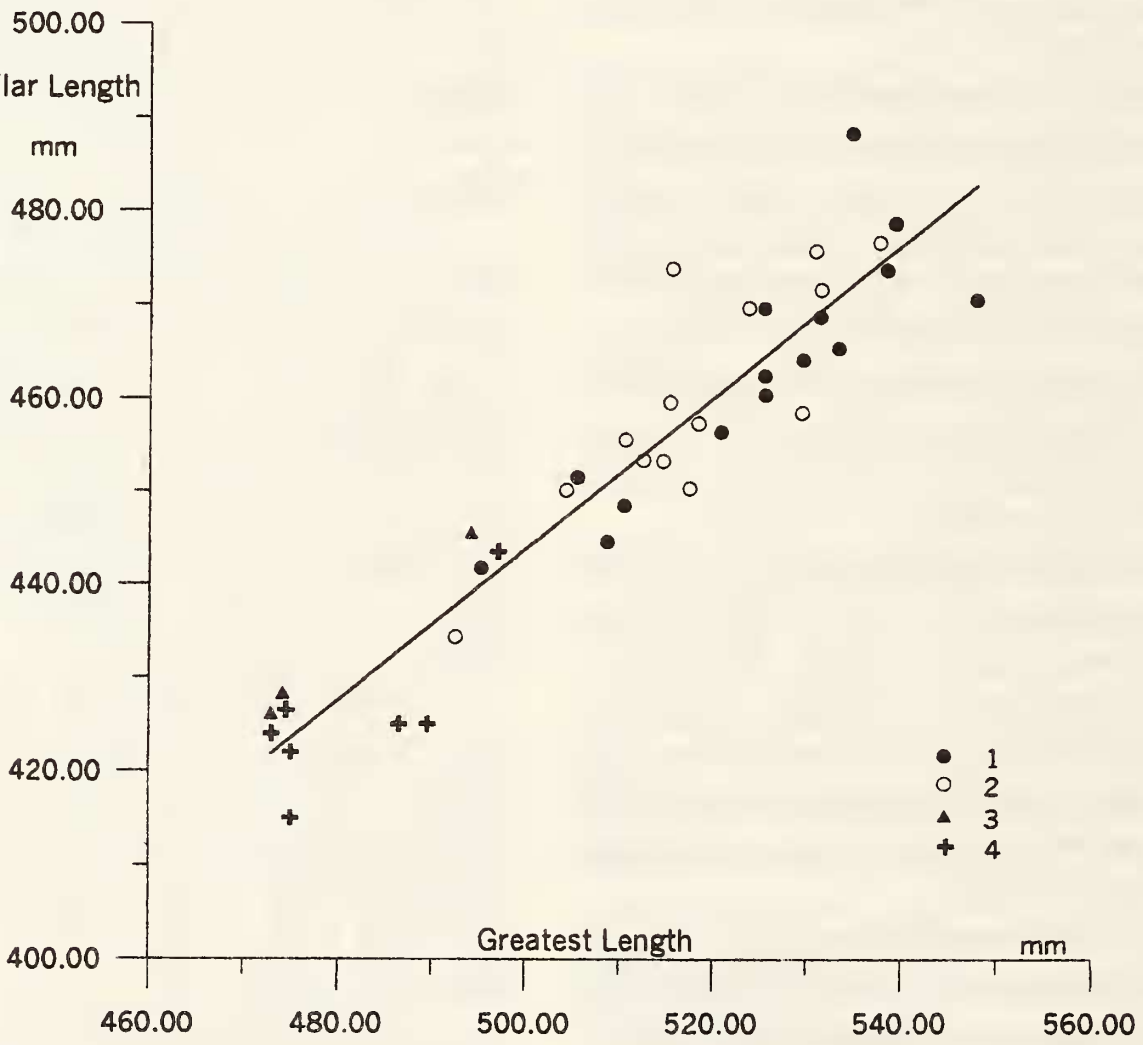
Results of comparisons: Single values for the 3 subspecies of kiangs are only found as graphics in Groves and Mazák (1967) without distinction between males and females. To enable a comparison between our measurements and the other kiang data, we digitised their figures and added them to our Figs 1, 2 and 3.

A comparison of length measurements of all kiangs (Fig. 1, basilar length vs greatest length) shows that *polyodon* is significantly smaller than the other kiang subspecies. While Groves and Mazák (1967, p. 352) observed a "long basal length compared to the greatest length" for 3 specimens

Table 1: Skull measurements

No.*	Measurement	Specification
1	Greatest length	Prosthion to inion
2	Basilar length	Prosthion to basion
3	Palatal length	Prosthion to hind border of palate, in midline
4	Diastema length	Hind border of I^3 alveolus to front border of P^2 alveolus
5	Toothrow length	Front border of P^2 alveolus to hind border of M^3 alveolus
6	Diastema breadth	Breadth of palatal surface in diastema region
7	Incisor breadth	Breadth of premaxillae across incisor alveoli
8	Palatal breadth	Breadth of palate between inner borders of P^3 alveoli
9	Orbital breadth	Breadth of skull across posterior margins of orbits
10	Occipital breadth	Breadth of occipital crest
11	Opisthion to inion	Distance from opisthion to inion
12	Nasal length	Length of the internasal suture

*Numbers refer to numbers on the abscissa in Fig. 4 and Fig. 5.



1=*holdereri*, 2=*kiang*, 3=*polyodon*; 4=*polyodon* (Schaefer's collection)

Fig. 1: Skull measurements of 3 subspecies of kiangs: basilar length vs greatest length, based on Fig. 9 in Groves and Mazák (1967), with additional skull data of the Southern kiang and with linear regression line for all data (n=39)

Neumann-Denzau, G. and H. Denzau: Southern kiang *Equus kiang polyodon* PLATE 1

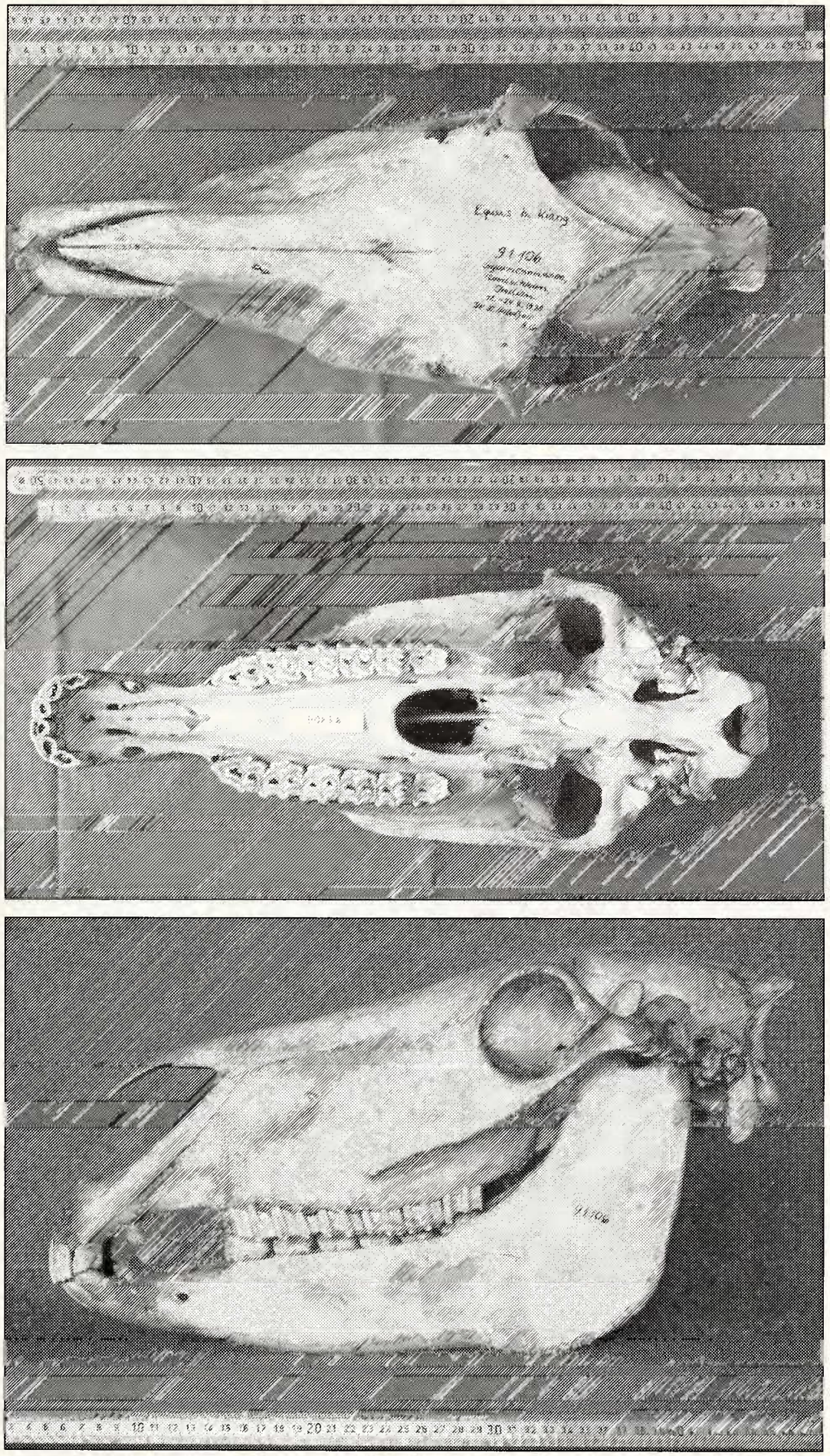


Fig. 1: Skull of Southern kiang (ZMB 91106) in dorsal, ventral and lateral view

Neumann-Denzau, G. and H. Denzau: Southern kiang *Equus kiang polyodon* PLATE 2

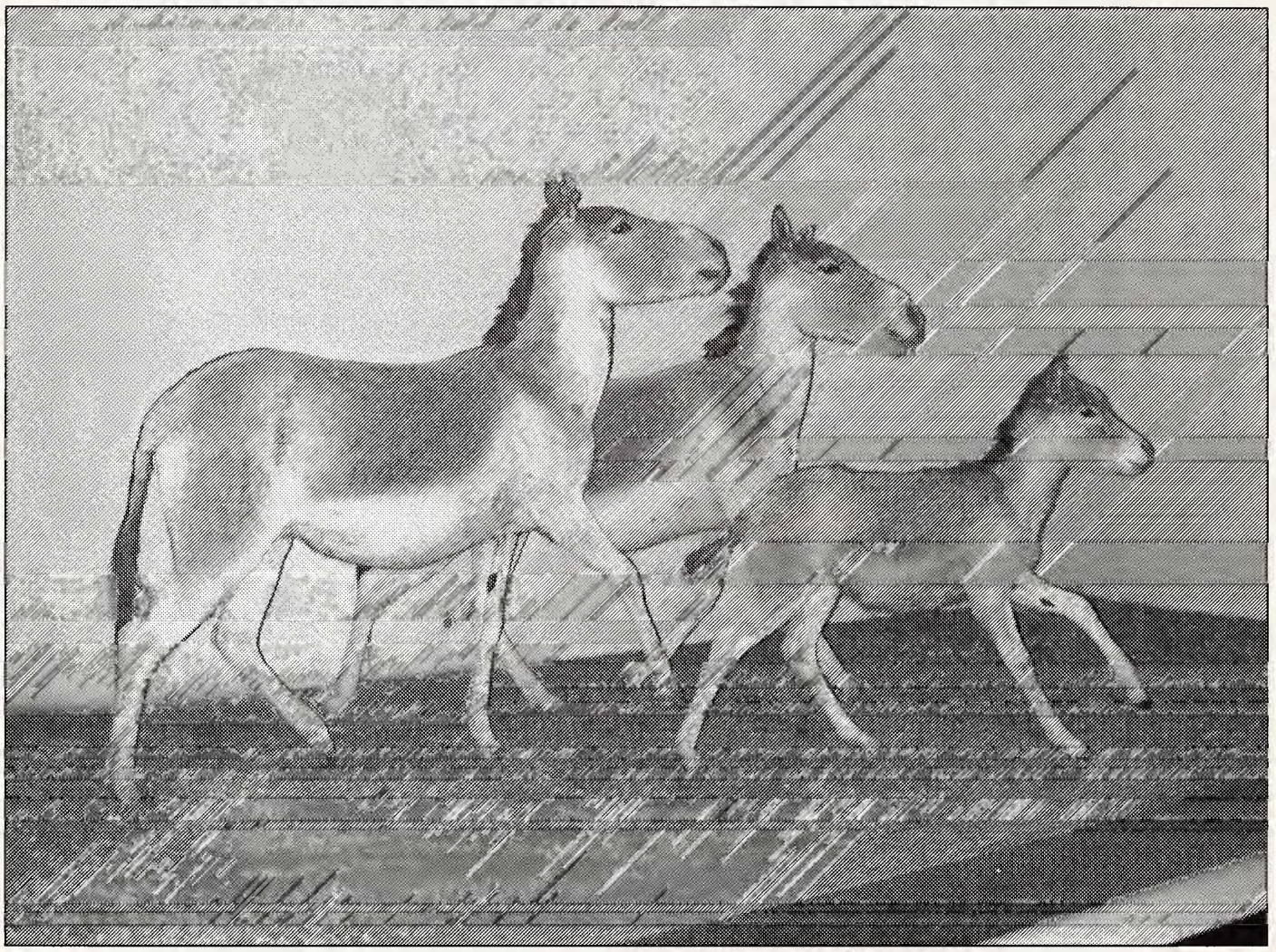


Fig. 1: Mounted group of Southern kiangs (Schaefer's collection)
in the Natural History Museum, Berlin

of *polyodon*, the 7 specimens of the Schaefer collection fit in well with the linear trend of all subspecies. Therefore, taking the now enlarged sample size of *polyodon* into statistical consideration, their statement cannot be corroborated.

However, on looking at the relation of skull breadth to length, it can be noticed that the measures of *polyodon* are not the smallest among the kiangs. The incisor breadth compared to the palatal length (Fig. 2) is, for example, quite large, indicating a broad muzzle.

On the other hand, the graph of 'nasal breadth vs nasal length' (Fig. 3) demonstrates that Western kiangs and Southern kiangs show no significant difference. The nasal breadth was taken at the point above the infraorbital foramen.

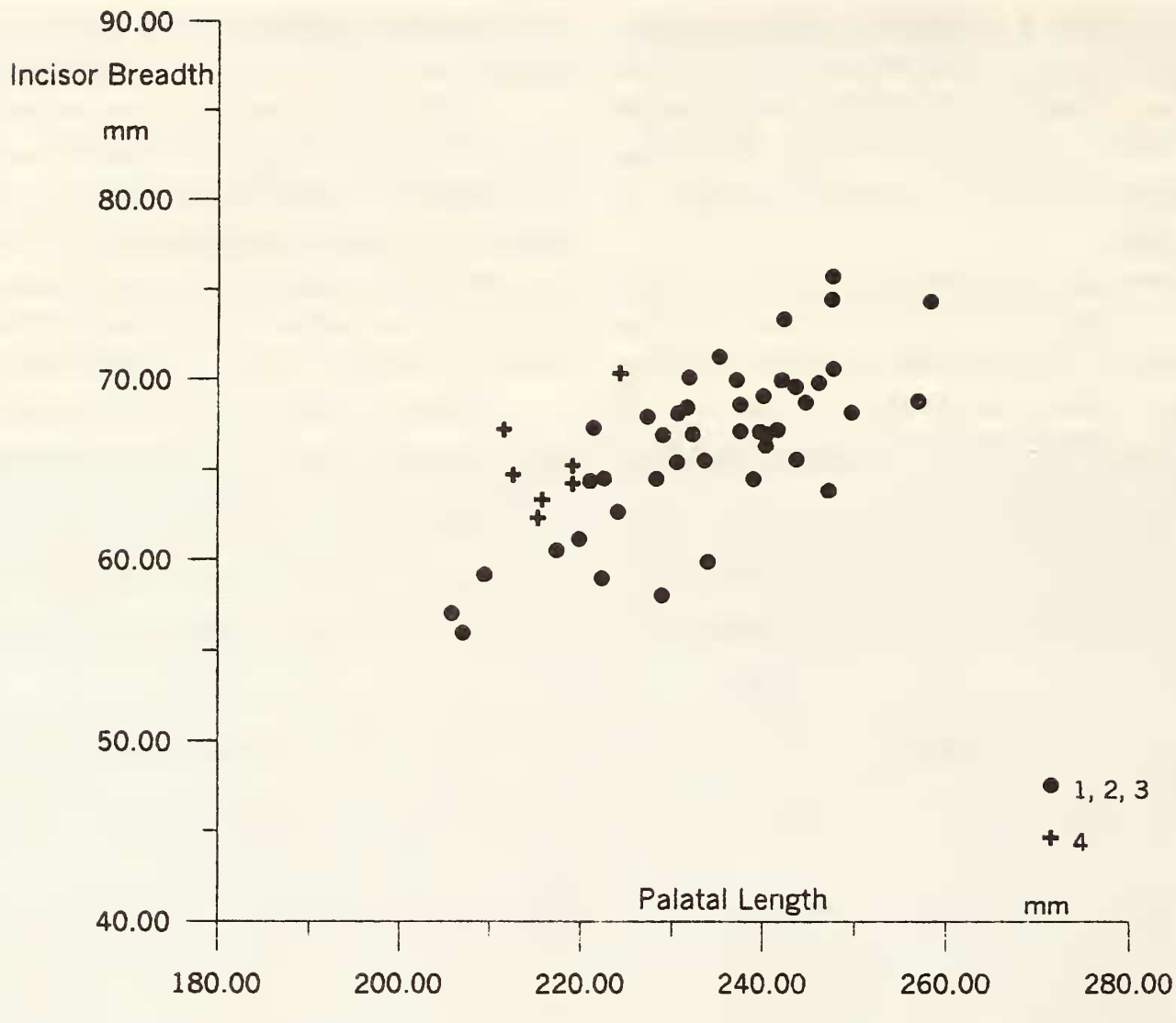
Table 2 contains the mean values of skull data of Southern kiangs in Schaefer's collection, in addition to skull measurements as published earlier by Groves and Mazák (1967). Despite the uncertainties regarding the origin of some of their skulls, the *polyodon* mean values of Groves and Mazák fit in well with the Schaefer data.

When comparing the differences of the skull mean values between the kiang subspecies and the kulan (*Equus hemionus kulan*), it becomes evident that the length measurements (1-5) of *polyodon* are almost equal to those of the kulan (Fig. 4). The breadth measurements 7 and 10 are

Table 2: Mean values of skull measurements of 3 kiang subspecies (in mm ±SE)

No.	Measurement	n	*holdereri* *	n	*kiang* *	n	*polyodon* *	n	*polyodon* **
Males:									
1	Greatest length	7	527.7 ±12.6	10	518.4 ±12.0	2	473.0	4	477.4 ±6.2
2	Basilar length	7	463.1 ±9.4	10	461.2 ±12.9	2	426.0	4	421.4 ±4.5
3	Palatal length	7	238.4 ±6.6	10	235.0 ±10.7	2	226.5	4	215.4 ±3.1
4	Diastema length	7	87.0 ±6.7	10	81.5 ±6.3	2	75.0	4	75.1 ±6.2
5	Toothrow length	5	168.2 ±3.3	5	159.8 ±4.0	3	156.0 ±2.6	4	150.5 ±4.6
6	Diastema breadth	7	47.3 ±3.5	10	45.9 ±2.0	2	40.0	4	44.8 ±3.8
7	Incisor breadth	7	69.1 ±4.0	10	69.8 ±3.0	2	66.0	4	64.5 ±2.2
8	Palatal breadth	7	60.6 ±4.3	10	55.4 ±6.5	3	45.7 ±2.1	4	51.8 ±3.8
9	Orbital breadth	7	207.4 ±6.8	10	211.8 ±8.3	3	201.3 ±5.1	4	206.2 ±4.8
10	Occipital breadth	7	58.9 ±2.9	10	55.2 ±4.0	2	53.5	4	55.2 ±2.7
11	Opisthion to inion	7	61.3 ±2.5	10	60.3 ±2.9	2	55.0	4	56.2 ±3.1
12	Nasal length	6	220.2 ±6.1	9	203.2 ±6.8	3	195.0 ±3.5	4	195.2 ±4.2
Females:									
1	Greatest length	7	519.3 ±14.7	5	514.2 ±9.0	3	481.0 ±11.3	3	487.0 ±11.5
2	Basilar length	7	458.1 ±11.5	5	456.4 ±7.5	2	436.5	3	431.7 ±10.3
3	Palatal length	7	240.7 ±8.3	5	238.3 ±3.2	3	226.0 ±4.7	3	218.6 ±5.9
4	Diastema length	7	86.0 ±6.5	5	88.6 ±6.5	3	79.0 ±2.2	3	76.9 ±4.3
5	Toothrow length	7	165.0 ±4.3	2	154.0	4	156.0 ±3.7	3	154.8 ±5.7
6	Diastema breadth	7	46.2 ±3.4	5	44.0 ±2.2	3	45.0 ±3.9	3	46.1 ±2.4
7	Incisor breadth	7	68.7 ±1.4	5	64.0 ±3.6	3	66.3 ±3.3	3	66.4 ±3.4
8	Palatal breadth	7	59.7 ±3.6	5	54.8 ±3.1	4	47.0 ±3.6	3	51.2 ±1.8
9	Orbital breadth	7	210.6 ±6.7	5	205.6 ±6.4	4	207.3 ±3.2	3	203.2 ±9.2
10	Occipital breadth	7	57.1 ±3.9	5	57.7 ±2.2	3	52.7 ±3.8	3	55.9 ±3.1
11	Opisthion to inion	7	63.4 ±2.4	5	62.3 ±4.1	2	59.5	3	56.9 ±4.8
12	Nasal length	3	223.0 ±11.0	3	203.6 ±4.0	3	198.3 ±5.3	2	189.7

* Data of Groves and Mazák 1967, p. 329.
** Schaefer's collection, ZMB.



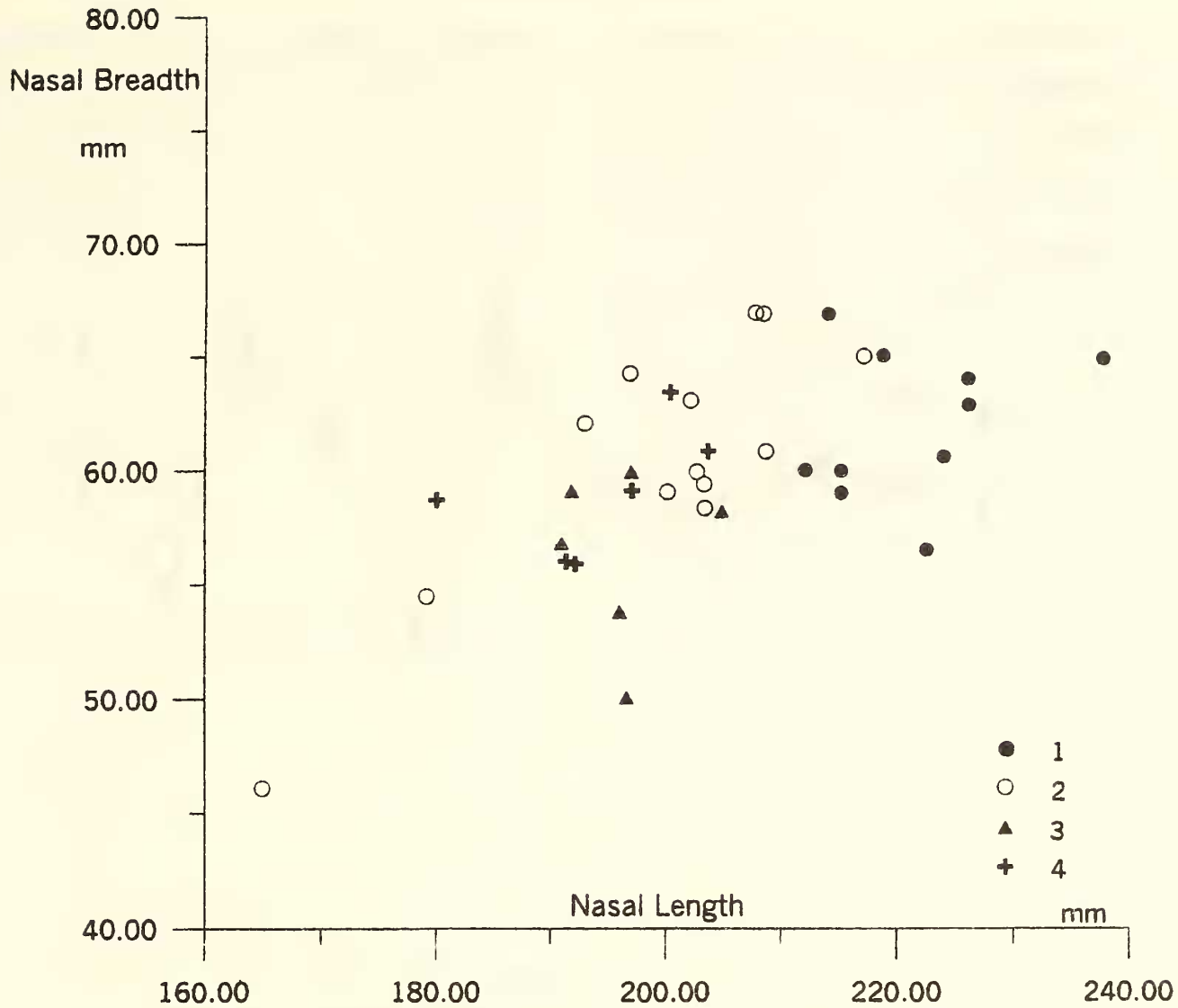
1,2,3=unspecified kiang subspecies; 4=*polyodon* (Schaefer's collection)

Fig. 2: Skull measurements of kiangs: incisor breadth vs palatal length, based on Fig. 7 in Groves and Mazák (1967), with additional skull data of the Southern kiang

about 10% larger, the measurements 8 and 11 on the other hand almost 10% smaller. Skull measurements of the Eastern kiang (*Equus kiang holdereri*) are always the largest.

Compared to the nominate form (*Equus kiang kiang*), the skull of the Southern kiang proves 8-10% smaller in length measurements 1-4 (Fig. 5). Measurements 8, 11 and 12 reveal certain differences among the 3 kiang subspecies. It is obvious that in the Southern kiang, not only the incisor breadth (7), but also the diastema breadth (6), the orbital breadth (9) and the occipital breadth (10) are proportionally larger than in other kiang subspecies. Due to these parameters we can characterise the Southern kiang as more broad-headed. This fact is the opposite of Trumler's erroneous statement, terming the heads of the Southern kiangs as rather horse-like, "slim and long."

Trumler (1959), after examining the skulls of kiangs, distinguished 3 different subspecies with the help of the 'Stirnbreitenindex'. His index is identical with the 'cephalic index' of Osborn (1912): frontal width at posterior borders of orbits, multiplied by 100, divided by basilar length. He found a cephalic index of 44-46 for the Eastern kiang, 46-49 for the Western kiang and only 43 for the Southern kiang. We determined a cephalic index of 48.1 ±1.5 for the 7 *polyodon* skulls of Schaefer's collection. The low value of Trumler for the Southern kiang is due to the erroneous use of some tanghan skulls.



1=*holdereri*, 2=*kiang*, 3=*polyodon*; 4=*polyodon* (Schaefer's collection)

Fig. 3: Skull measurements of kiangs: nasal breadth vs nasal length, based on Fig. 12 in Groves and Mazák (1967), with additional skull data of the Southern kiang

We found the shape of the face in lateral view slightly more box shaped in the Southern kiang and more inclined in the other kiangs.

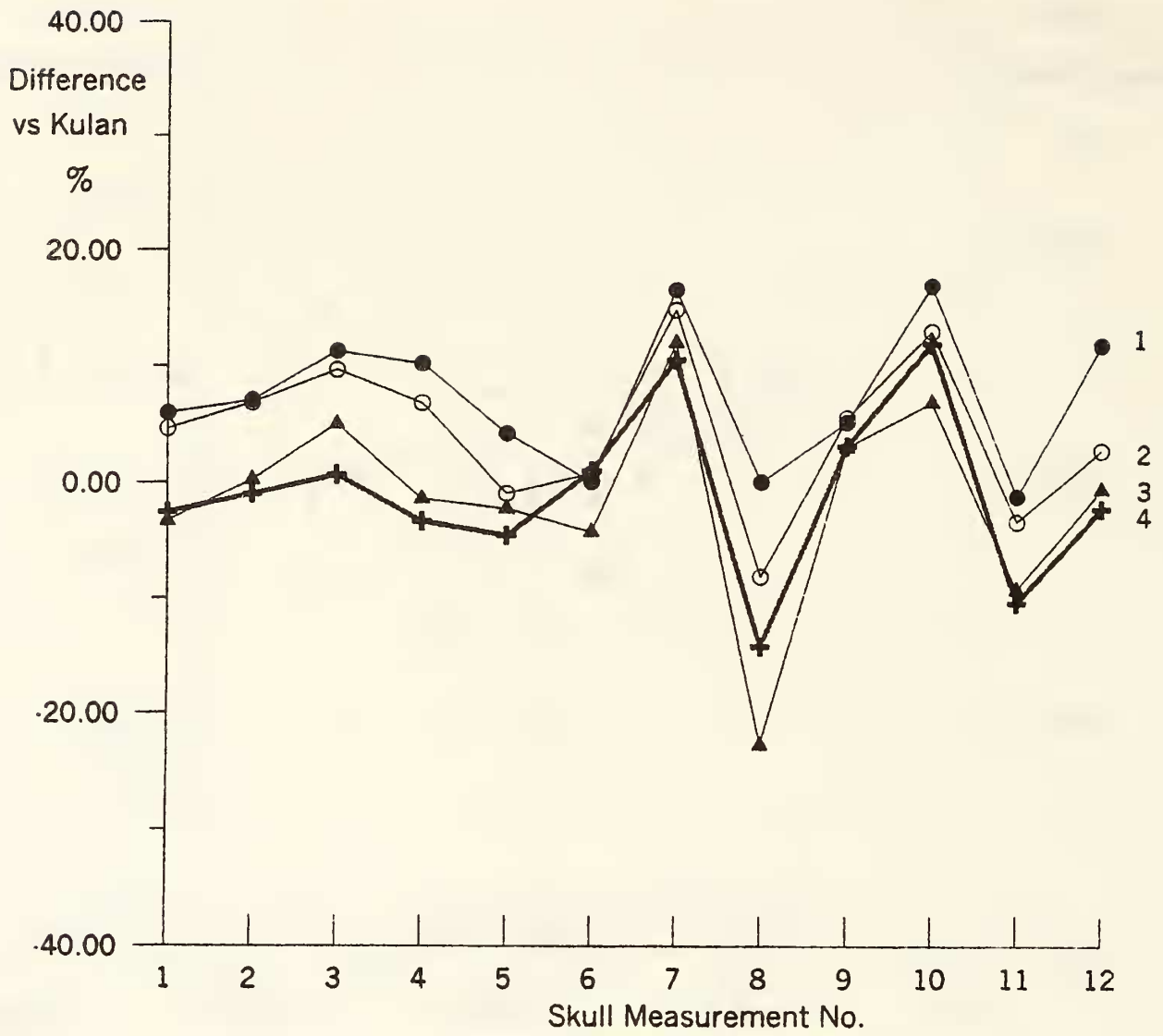
Among the 7 skulls of adults of the Schaefer collection, 5 have at least one 7th tooth (premolar P1) in the upper jaw. Groves and Mazák (1967) examined the presence of P1 in different equid species and they too found a high ratio (8 in 11) of kiangs with presence of P1.

Morphology

In the ZMB exhibit, there is a mounted kiang group (male, female and foal) which could not be identified so far, as none of the museum documents mention this kiang group (Plate 2, Fig. 1). However, with the help of a newspaper article (A.C.L. 1940) we could confirm that a stallion, a mare and a foal of the 1938-39 expedition were indeed selected for dermoplastic modelling. J.M. Dolan (1999) misidentified this group as a member of the *holdereri* type from Schaefer's 2nd expedition.

The two adults within the mounted Southern kiang group in the ZMB have shoulder heights of 113 cm and 115 cm (our measurements).

The height at shoulder of dead specimens is given by Hodgson (1847a) as 3 ft 9 in. (114.3 cm) for a male, and 3 ft 5 in. (104.1 cm) for a female (printing error?), whereas Bailey (1910) gives 48.5 in. (123.2 cm) for a female. The mounted kiang in Leiden (collected by Hodgson) stands 117 cm tall at the shoulder (our measurement).



1=*holdereri*, 2=*kiang*, 3=*polyodon*; 4=*polyodon* (Schaefer's collection)

Fig. 4: Percent difference in average skull data of 3 subspecies of kiangs in comparison to *Equus hemionus kulan* at null axis, based on Table 2 [for measurement numbers see Table 1; kulan data taken from Groves and Mazák (1967)]

Although data taken on dead or mounted animals may differ slightly compared with data of live animals, it can be concluded from the available data that the Southern kiang has an average shoulder height between 110-120 cm (thus one of the smallest living wild equids).

Groves (1974) writes: "These southern kiangs, south of the upper Brahmaputra, are much smaller than the big north-eastern ones, only 100-115 cm high." He characterised the Western kiang as 135 cm high and of very dark colour and the Eastern kiang as 140 cm high and of light colour.

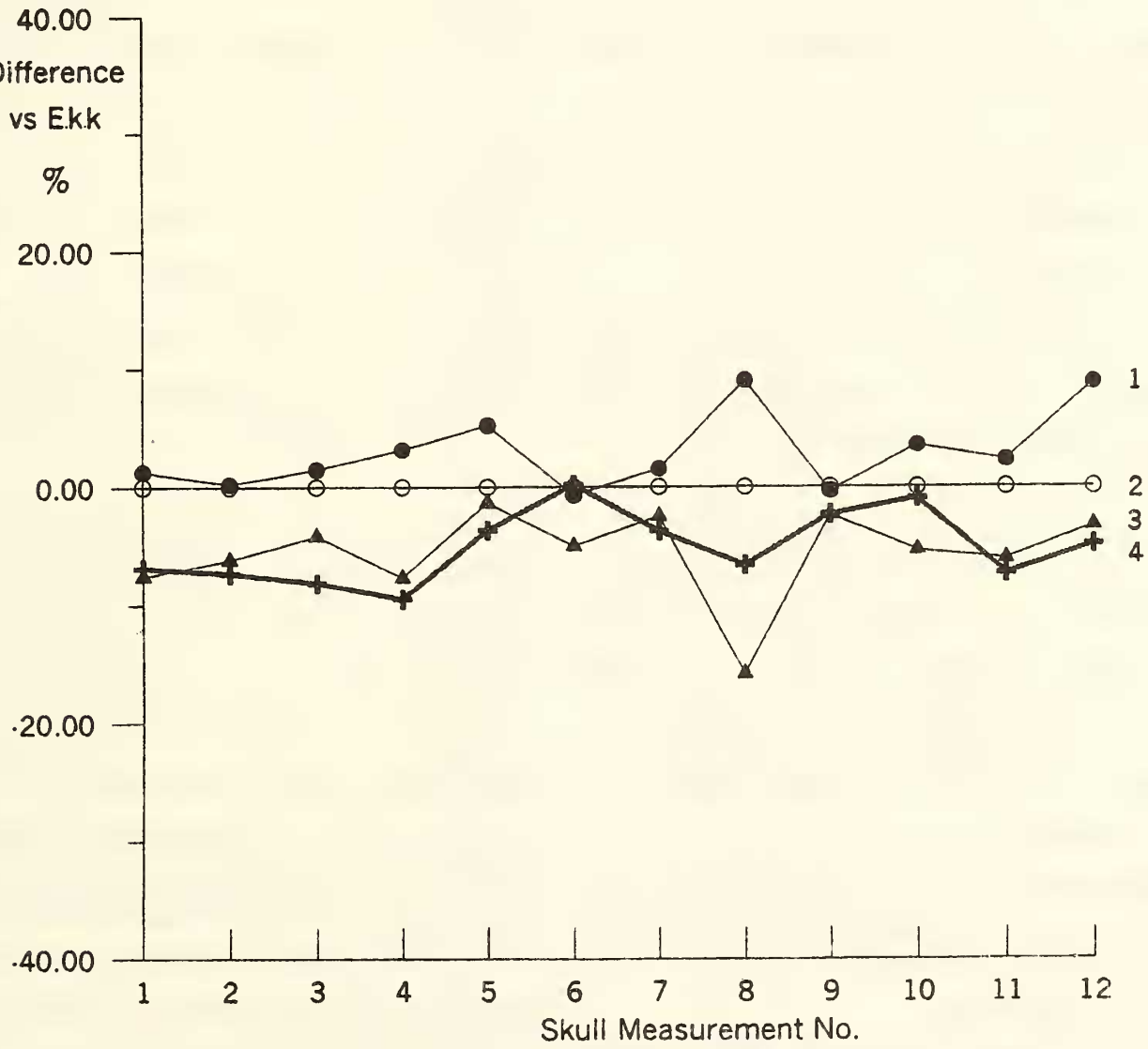
Schaller (1998) wrote: "I have observed the three supposed subspecies and noted no marked difference in size or colour. Although slight regional variation in kiangs may exist, an acceptance of subspecies seems premature." He photographed a group of 7 Southern kiangs in 1995 (erroneously printed:1985) in the Chigo Co area, south of Lhasa (Schaller 1998, p. 169). Besides his photograph, we have seen very few pictures of the Southern kiang, as in Shah (1994, Plate 2) with a group of kiangs in the Bamchona area in northern Sikkim, a picture of a dead female and a foal in Bailey (1910, Plate A), and a group of animals in Schaefer (1950, opp. p. 128). A black and white film with the German title 'Geheimnis Tibet' shows some sequences with herds of kiangs, filmed by Schaefer's expedition in north Sikkim and south Tibet in 1938-39.

Mounted animals and skins in different museums are quite old and faded in colour and have not been thoroughly examined for this study. However, taking all impressions together, the Southern kiang appears to have a shorter brown elongation from the back down to the shoulder than the other kiangs, and thus larger white portions on the chest, a larger white wedge from the belly upwards to the shoulder and the outer sides of the front legs white. The white field on the flank is indistinct.

GEOGRAPHY

Historical sightings and descriptions: Only a very few kiangs of the southern range have ever been caught alive. Turner (1800) mentioned hearing that 4 kiangs were once in Warren Hastings' possession. It can be presumed that these were brought down by Bogle, who travelled to Teshu Lumbo (near Shigatse/ south Tibet) in 1774, commissioned by Hastings, the first Governor-General of Bengal, with an order to collect wild animals and seeds besides other rare goods.

Bailey (1910, 1911b) had reared two foals of the Southern kiang with the help of ponies as foster-mothers during his time as a trade agent in Gyantse. The Dalai Lama used to keep tame kiangs on a 'Wild Ass Meadow' between his summer residence and the state palace of his mother on the western outskirts of Lhasa (see map in Waddell



1=*holdereri*, 2=*kiang*, 3=*polyodon*; 4=*polyodon* (Schaefer's collection)

Fig. 5: Percent difference in average skull data of 3 subspecies of kiangs in comparison to the Western kiang (*Equus kiang kiang*) at null axis, based on Table 2 [for measurement numbers see Table 1]

1904). These semi-tame kiangs, three mares, allowed Walton (1905) to approach to within twenty yards (18 m) of them. Waddell (1905) mentioned that two of the kiang mares from the captive stock (of unknown origin, maybe even crossbreeds of different captive subspecies) of the Dalai Lama were taken as a present to King Edward VII. One mare was drowned while crossing the Tsangpo (Brahmaputra), the other landed safely in England in January 1905 and died, according to Dolan (1999), in 1915. A skull from "near Lhasa" (BM 5.6.20.1, listed by Lydekker 1916), possibly that of the drowned animal (same presenter for live and dead specimen: G.R. Macdonald), was examined by Groves and Mazák (1967) and described as follows: "though most like *holdereri*, does not fit satisfactorily into the race because of its (the specimen's) very long basal length, proportional to greatest length: a feature observed in *polyodon* as well. It may therefore be suggested that the specimen is a member of basically *holdereri* population affected by some intergradation with *polyodon*."

We investigated many old travel reports in the area south of latitude 32° N and determined the locations of historical kiang sightings as far back as possible. Recent references were also included. The locations, coordinates and references of kiang observations supposed to belong to the southern subspecies range are summarised in Table 3a, the information of other possible kiang sightings, in Table 3b. We have included available data from the year 1774 onwards. The coordinates are given, with a few exceptions, as precisely as kiang observations could be localised.

Geographical distribution: Our map (Fig. 6) shows the recorded kiang sightings, according to Tables 3a and b, with our interpretation of the distribution boundaries.

The northern boundary of the Southern kiang's geographical distribution is either the upper Brahmaputra (Tsangpo) or perhaps the Nyenchen Tanghla Mountain Range to the north of that river. It can be seen that *polyodon* might have its western and northern distribution boundaries at 88° E and at 29° N (except one location east of Lhasa). The kiangs west of 88° E and between 28° N and 29.5° N need to be specially investigated (our suggestion), for finding out which subspecies they really belong to. Another suggestion is that if Southern kiangs inhabit Bhutan at all, they should be looked for in the extreme northeast.

If the gap in the kiang distribution south of the Brahmaputra, between 87°-88° E, proves to be true, it could be explained by the glaciation history in the area of the Upper Arun and its tributaries. Evolution of subspecies is usually an effect of long-term isolations between populations. The separation of the Southern kiang from the other kiangs was possibly caused by glacio-tectonic forces during the Pleistocene or Late Glacial period. Kuhle (2001) explains that big ice sheets must have existed in south Tibet due to the damming effect of the Himalayan mountain wall, which found their drainage via the steep south slopes. The glaciation of the Arun river valley, between Mt Everest and Kangchenjunga, is confirmed by glaciogeological findings.

Our map (Fig. 6), which is based on more recorded kiang sightings than any previous distribution map, is in agreement with the map of Schaller (1998, p. 164), regarding a continuous east-west extension from the western towards the eastern kiangs. While Schaller also connects the southern distribution range with that of the other kiangs, Groves (1974, p. 95) as well as Denzau and Denzau (1999, p.50 and back cover) keep the southern subspecies geographically apart. Groves (1974), in his map, left a big gap between the eastern and western subspecies, but allowed the range of the Eastern kiang to meet that of the Southern kiang along the Brahmaputra. It seems that Groves (1974), as well as Groves and Ryder (2000), when including the Lhasa district in the geographical range of *holdereri*, have used the skull BM 5.6.20.1, mentioned earlier, for this claim. Our

Table 3a: Locations of sightings of southern kiangs

Location	Coordinates	Reference
Bam-tso	28.1° N, 89.3° E	Howard-Bury 1922
Bhomtso	28.1° N, 88.8° E	Hooker 1855
Bomchho La =Bamchhola	28.1° N, 88.7° E	Ali 1981, Lachungpa 1994, Shah 1994, Avasthe and Jha 1999
Chho Lhamu =Cholamoo Lake	28.0° N, 88.8° E	Campbell 1852, Ali 1981, Lachungpa 1994, Shah 1994, Ganguli-Lachungpa 1999, Avasthe and Jha 1999
Chhomodo	28.1° N, 88.7° E	Shah 1994
Chigo Co	28.7° N, 91.7° E	Schaller 1998
Chulung Valley, Chhulung La	28.1° N, 88.6° E	Shah 1994, Avasthe and Jha 1999
Chumulari - Phari	27.8° N, 89.2° E	Campbell 1848, Campbell 1852
Dingcham Province*		Hooker 1855
Dinggye	28.3° N, 88.1° E	Zhang 1997
Dochen	28.1° N, 89.3° E	Bailey 1910
Donkyala	28.0° N, 88.8° E	Shah 1994
Geree	28.2° N, 88.5° E	Campbell 1852
Gurudongmar	28.0° N, 88.7° E	Shah 1994
Gyakang =Gayokang	28.0° N, 88.6° E	Schaefer SIII, Schaefer 1950
Gyam-tso-na =Gyamchhona =Yeumtso	28.1° N, 88.6° E	Campbell 1852, White 1909, Schaefer 1950, Avasthe and Jha 1999
Gyisum - Nyala La	28.1° N, 92.2° E	Bailey 1957
Kala Lake	28.3° N, 89.5° E	Schaefer 1950
Kala Lake - Sameda	28.3° N, 89.6° E	Schaefer 1950, Schaefer SIII
Kamba-jong	28.3° N, 88.5° E	Campbell 1852, Walton 1905
Kangmar	28.5° N, 89.7° E	Bailey 1911a
Keraang, east of Chho Lhamu	28.0° N, 88.8° E	Lachungpa 1994, Shah 1994
Khamba (coming from Lake Teltung)	28.4° N, 88.4° E	Das 1902
Khongjakna (east of)	28.0° N, 88.9° E	Shah 1994
Kiang-lah mountains (running east-west at)	28.3° N, 88.2° E	Hooker 1855
Kurma	28.5° N, 88.7° E	Das 1902
Lapshi	28.2° N, 92.4° E	Bailey 1957
Lungma (east of)	28.3° N, 88.7° E	Denman 1954
Mendza (from Tangla to)	28.4° N, 89.6° E	Bailey 1911a
Nyala La (northeast of Tsöna)	28.2° N, 92.2° E	Bailey 1915
Oleten	28.0° N, 88.8° E	Shah 1994
Pawhunri base	28.0° N, 88.9° E	Kellas 1912
Sese La	28.0° N, 88.8° E	Lachungpa 1994, Shah 1994, Avasthe and Jha 1999
Sham-chu Pelling	28.2° N, 89.4° E	Bogle 1774 in: Markham 1876
Tangla	27.9° N, 89.2° E	Turner 1800
Tang La - Tuna	27.9° N, 89.3° E	Hayden and Cosson 1927, Schaefer 1950
Tratsang - Pu La	28.8° N, 92.3° E	Bailey 1957
Tulung La (southeast of Tsöna)	27.9° N, 92.2° E	Bailey 1915
Tuna	28.0° N, 89.2° E	Waddell 1905, Walton 1905
Tuna - Dotschen	28.0° N, 89.3° E	Hayden and Cosson 1927, Schaefer 1950
Uyu La - Yamdrok Tso	28.6° N, 90.7° E	Bailey 1924
Vi-si-king	29.7° N, 92.1° E	Hodgson 1832
Yamdrok Co	28.8° N, 91.4° E	Schaller 1998
Yumchho	28.0° N, 88.7° E	Avasthe and Jha 1999

*skirts the frontier of Sikkim, Bhutan and Nepal

Table 3b: Locations of sightings of (possibly) other kiangs south of latitude 32° N

Location	Coordinates	Reference
Baingoin	31.7° N, 89.8° E	Zhang 1997
Daggtse-tso	31.8° N, 87.3° E	Hedin 1903
Dschandin-tso	31.7° N, 85.4° E	Hedin 1903
Garing Cho (east side)	32.0° N, 89.2° E	Littledale 1896
Jaggju-rappga/Selling-tso	32.0° N, 88.8° E	Hedin 1903
Kjangdam	30.2° N, 87.0° E	Hedin 1909-1912
Langkar Mo	31.6° N, 87.5° E	Bower 1894
Mar-khung - Gemar	31.2° N, 87.1° E	Hayden and Cosson 1927
Mustang (Chhujung and Damodar Kunda)	29.3° N, 84.0° E	Anon. 1999
Nagmo	32.0° N, 86.8° E	Bower 1894
Namru region	31.7° N, 90.2° E	Hayden and Cosson 1927
Nam Tso (east of)	30.8° N, 91.1° E	Hayden and Cosson 1927
Ngang-Tsi Tso (northern shore)	31.2° N, 87.0° E	Hayden and Cosson 1927
Nyalam (villages: Ngora, Khoryak)	28.2° N, 85.9° E	Jackson 2000
Pegu Tso	29.0° N, 85.6° E	Jackson 1991
Shen-tsa - A-chen-tsongo	30.9° N, 88.8° E	Hayden and Cosson 1927
Takbur-La	29.4° N, 85.1° E	Hedin 1909-1912
Tarbar ('Moskitolager' east of)	30.1° N, 84.0° E	Landor 1898
Tong-chu (south of)	31.8° N, 89.2° E	Hayden and Cosson 1927
Xainza	30.9° N, 88.7° E	Zhang 1997
Xixabangma (northern flank)	28.5° N, 85.8° E	Zhang 1997
Zhongba	29.7° N, 84.1° E	Zhang 1997

careful investigations show that the distribution boundary of *holdereri* does not touch Lhasa, but remains about 110 km further north. The sighting of a kiang east of Lhasa and north of the Brahmaputra (as reported to Hodgson in 1832) remains uncertain regarding the subspecies question and is perhaps a doubtful point in our Southern kiang distribution map (Fig. 6). However, we did not want to exclude any information. With the help of our documentation it will be easier to re-interpret the subspecies distribution data in future, if more facts are ascertained.

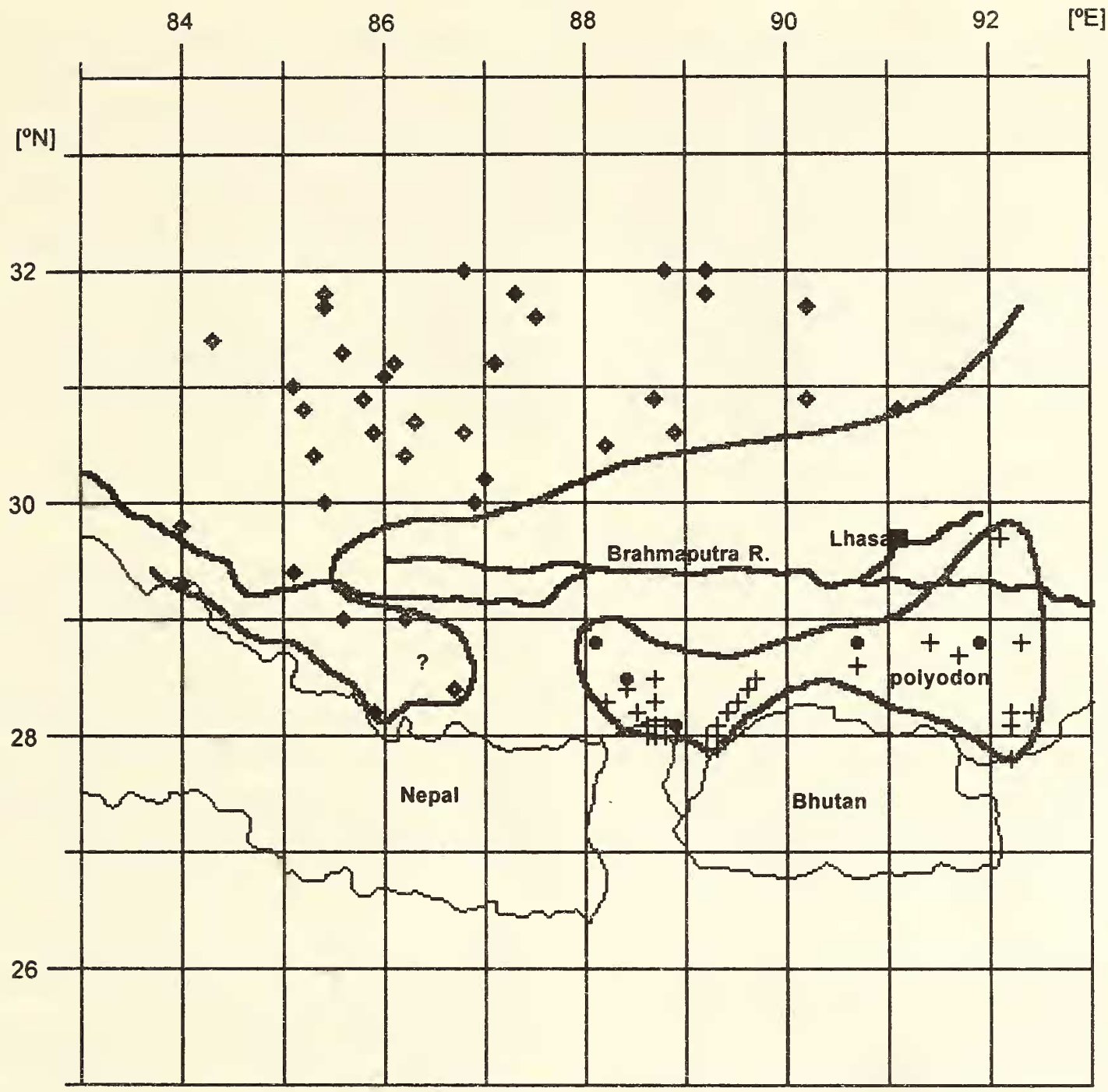
Present Situation

Official conservation status (for *Equus kiang* in general): in China it is listed in first category of the State Key Protected Wildlife List (Wang 1998), in India in Schedule 1 of the Wildlife (Protection) Act, 1972 (Agrawal 1994). The Southern kiang is listed as 'DD' (Data Deficient) in the '2000 IUCN Red List of Threatened Species' (Hilton-Taylor 2000), but deserves a threatened classification as endangered 'EN C2a', since the total population is estimated to number less than 2,500 mature individuals, severely fragmented, with no subpopulation estimated to contain more than 250.

Partial population estimates: Today's population density of the Southern kiang is largely unknown and only a few authors have published their observations.

Schaller (1998) mentioned, "During a wildlife survey in October 1995 we attempted to delineate current distribution between the Bhutan border and the Yarlung Tsangpo. According to local people, the kiangs were exterminated in most areas between the 1960s and 1980s. In that eastern part of their range we found kiangs around Chigo Co in three populations totalling probably no more than 200 animals; and others persist just south of Yamdrok Co."

Ali (1981) had reported two kiang groups (consisting of 10 and 7 individuals) during his



Symbols: 1=Southern kiang * 2=other kiangs **
3=Southern kiang *** 4=other kiangs ***

* locations according to Table 3a
** locations according to Table 3b
*** additional sightings according to Fig. 10.1 in Schaller (1998)

1
2
3
4
Kiang distribution

Fig. 6: Recent and historical sightings of kiangs in southern Tibet, Nepal and Sikkim (between 27°-32° N and 84°-93° E) with proposed distribution boundaries for the Southern kiang

ecological studies in north Sikkim in summer 1978 and summer 1979.

Lachungpa (1994) summarised her few kiang observations during 9 visits (4 without any kiang sightings) to north Sikkim during a period of 5 years (September 1989 - September 1994). Her list shows a total of 52 kiangs in 5 groups (group size ranging from 4 to 16). She estimated no more than 10-40 seasonally free-ranging Southern kiangs in Sikkim.

Shah (1994), while conducting a survey in north Sikkim between October 29 and November 15, 1994, counted a total of 74 kiangs in 14 groups (group size ranging from 1 to 48). Taking additional sightings by army personnel into account, she estimated a total population of 74-120 Southern kiangs in Sikkim and the adjacent areas of China. Interviewing the local nomads, she came to know that kiangs are sighted all year round.

Threats: Mahapatra (1998): "In 1962 the Indian Army was invited over to Sikkim, and has remained in border areas inaccessible to most researchers. Landmines have been laid in many patches in these areas. This has not only prevented study of rare animals like the kiang, but also led to decimation of its population. According to army officials, the three-strand barbed wire fencing around landmined areas has been damaged at many places in Dongkung-Chho Lhamo. But these patches of lush green grass attract kiangs and locals have often reported seeing kiangs being blown apart by landmines."

Also, Raj (1999) describes the minefields between China and India along the Sikkim border as the main casualty factor for rare wildlife including the kiang: "villagers have reported seeing herds of wild animals charging across the Tibetan border after being fired at by Chinese soldiers only to meet their end in the Indian minefields." Lachungpa (1994) mentioned the sighting of a lame kiang with the remark "landmine casualty."

Natural calamities include high snowfall in winter and predation of foals by wolves. Domestic livestock is a serious grazing competitor (Shah 1994).

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References

A.C.L. (1940): Besuch im Zoologischen Museum in der Invalidenstrasse. *Berliner Illustrierte Nachrichten, 24.10.1940, 2. Beiblatt zu Nr. 250*: 4.

Agrawal, V.C. (1994): Tibetan Wild Ass or Kiang. Pp. 161-162. *In*: The Red Data book on Indian animals, Part 1: Vertebrata. Zoological Survey of India, Calcutta.

Ali, S.M. (1981): Ecological reconnaissance in Eastern Himalaya. *Tigerpaper 8(2)*: 1-3.

Anon. (1999): Kiang: The Tibetan wild ass. (www.south-asia.com/kingmah/greenwat.htm downloaded 18.Dec.2001).

Avasthe, R. & A. Jha (1999): Mammals of Sikkim. WWF Sikkim, Gangtok. 97 pp.

Bailey, F.M. (1910): A young kyang or Tibetan wild ass. *J. Bombay nat. Hist. Soc. 19*: 731 +Pl. A.

Bailey, F.M. (1911a): Notes on the game animals from near Gyantse and the Chumbi Valley. *J. Bombay nat. Hist. Soc. 20*: 1028-1032.

Bailey, F.M. (1911b): A quiet day in Tibet. *Blackwood's Magazine 189 (No. 1144)*: 270-275.

Bailey, F.M. (1915): Notes from Southern Tibet. *J. Bombay nat. Hist. Soc. 24*: 72-78.

Bailey, F.M. (1924): Through Bhutan and Southern Tibet. *Geogr. J. 64*: 291-297.

Bailey, F.M. (1957): No passport to Tibet. The Travel Book Club, London. 294 pp.

Blyth, E. (1863): Catalogue of the mammalia in the museum of the Asiatic Society. Calcutta. Pp. 135-136.

Bower, K. (1894): A diary of a journey across Tibet. London, (Repr. Manjusri, New Delhi 1970). 309 pp.

Campbell, A. (1848): Itinerary from Phari in Thibet, to Lassa. *J. Asiat. Soc. Bengal 17(1)*: 257-276.

Campbell, A. (1852): Diary of a journey through Sikim to the frontier of Thibet. *J. Asiat. Soc. Bengal 21*: 407-428, 477-501, 563-575.

Das, S.C. (1902): Journey to Lhasa and Central Tibet. Murray, London. 285 pp.

Denman, E. (1954): Alone to Everest. Collins, London. 255 pp.

Denzau, G. & H. Denzau (1999): Wildesel. Thorbecke,

Stuttgart. 221 pp.

DOLAN, J.M. (1999): An overview of the kiangs, *Equus kiang* Moorcroft, 1841, kept in European and North American zoological collections prior to 1970. *Equus 2(3)*: 253-268.

EISENMANN, V. (1986): Comparative osteology of modern and fossil horses, half-asses and asses. Beihefte zum Tuebinger Atlas des Vorderen Orients, Reihe A, Nr.19/1, Wiesbaden. Pp. 67-116.

EISENMANN, V. & N. SHAH (1996): Some craniological observations on the Iranian, Transcaspian, Mongolian and Indian hemiones. EEP Yearbook 1995/96, Amsterdam. Pp. 396-399.

GANGULI-LACHUNGPA, U. (1999): Amidst wildlife in Sikkim. *Hornbill (Sept.-Nov.)*: 4-7.

GERRARD, E. (1862): Catalogue of the bones of mammalia in the collection of the British Museum. London. Pp. 272-274.

GRAY, J.E. (1846): Catalogue of the specimens and drawings of mammalia and birds of Nepal and Thibet, presented by B.H. Hodgson to the British Museum. London. 156 pp.

GRAY, J.E. (1849): Notes on the skull of *Equus hemionus* and *Equus kiang*. *Proc. Zool. Soc. London 17*: 29-30.

GRAY, J.E. (1852): Catalogue of the specimens of mammalia in the collection of the British Museum. Part III: Ungulata furcipeda. British Museum, London. Pp. 272-275.

GRAY, J.E. (1863): Catalogue of the specimens and drawings of mammals, birds, reptiles, and fishes of Nepal and Tibet, presented by B.H. Hodgson to the British Museum. British Museum, London. 90 pp.

GROVES, C.P. (1974): Horses, Asses and Zebras in the Wild. David & Charles, Newton Abbot. 192 pp.

GROVES, C.P. & V. MAZÁK (1967): On some taxonomic problems of Asiatic wild asses; with the description of a new subspecies (Perissodactyla; Equidae). *Zeitschr. Saeugetierk. 32*: 321-355.

GROVES, C.P. & O.A. RYDER (2000): Systematics and phylogeny of the horse. Pp. 1-24. *In*: The genetics of the horse (Eds.: Bowling, A.T. & A. Ruvinsky). CABI Publishing, Wallingford, Oxon.

GUPTA, J.L. (Ed.) (1987): A journey to Lake Mansarovara (by William Moorcroft). Gian Publishing House, Delhi. 139 pp.

HAYDEN, H. & C. COSSON (1927): Sport and travel in the highlands of Tibet. Cobden-Sanderson, London. 262 pp.

HEDIN, S. (1903): Im Herzen von Asien. Vol. 2. Brockhaus, Leipzig. 390 pp.

HEDIN, S. (1909-1912): Transhimalaja. Vol. 2. Brockhaus, Leipzig. 406 pp.

HILTON-TAYLOR, C. (2000): 2000 IUCN Red List of threatened species, IUCN, Gland. Pp. 61 + CD.

HODGSON, B.H. (1832): Route from Cathmandu, in Nepal, to Tazedo, on the Chinese frontier. *Asiatic Researches 17*: 513-534.

HODGSON, B.H. (1842): Notice of the mammals of Tibet, with descriptions and plates of some new species. *J. Asiat. Soc. Bengal 11*: 275-289.

HODGSON, B.H. (1847a): Description of the wild ass and wolf of Tibet. *Calcutta J. Nat. Hist. 7*: 469-477, pl. 6+7.

HODGSON, B.H. (1847b): Note on the kiang. *Calcutta J. Nat. History 8*: 98-100.

HOOKER, J.D. (1855): Himalayan Journals. Murray, London. Vols. 1+2, 348+345 pp.

HOWARD-BURY, C.K. (1922): The Mount Everest expedition. *Geogr. J. 59*: 81-99.

HUNTER, W.W. (1896): Life of Brian Houghton Hodgson. Murray, London. Pp. 390.

JACKSON, R. (1991): Snow leopards and other wildlife in the Qomolangma Nature Preserve of Tibet. *Snow Line 9(1)*: 9-12.

JACKSON, R. (2000): Community participation: tools and examples. Paper presented at the Management Planning Workshop for the Trans-Himalayan Protectes Areas, 25th-29th August 2000, Leh. (www.snowleopardconservancy.org downloaded 19.Dec.2001).

JENTINK, F.A. (1887): Catalogue osteologique des mammiferes. Vol. 9. Museum d'Histoire Naturelle des Pays-Bas, Leiden.159 pp.

JENTINK, F.A. (1892): Catalogue systematique des mammiferes. Vol. 11. Museum d'Histoire Naturelle des Pays-Bas, Leiden. 188 pp.

KELLAS, A.M. (1912): The mountains of Northern Sikkim and Garhwal. *Geogr. J. 40*: 241-263 + map.

KUHLE, M. (2001): The glaciation of High Asia and its causal relation to the onset of ice ages. *Die Erde 132*: 339-359.

LACHUNGPA, U. (1994): Tibetan wild ass or kiang not extinct in Sikkim. *Sikkim Science Newsletter 7(3)*: 7-9.

LANDOR, H.S. (1898): Auf verbotenen Wegen. Brockhaus, Leipzig. 511 pp.

LITTLEDALE, G.R. (1896): A journey across Tibet, from north to south, and west to Ladak. *Geogr. J. 7(5)*: 453-483 + maps.

LYDEKKER, R. (1916): Catalogue of the ungulate mammals in the British Museum (Natural History). British Museum, London. Pp. 8-11.

MAHAPATRA, R. (1998): Beauty and biology: the Shangri-

La. *Down to Earth 7(3)*: internet edition (www.downtoearth.org downloaded 9.Jan.2002).

MARKHAM, C.H. (ED.) (1876): Narrative of the mission of George Bogle to Tibet and the journey of Thomas Manning to Lhasa. Truebner & Co., London. 354 pp.

MOORCROFT, W. (1824): Letter of W. Moorcroft to John Fleming, dated Leh, April 25, 1822, read June 21, 1823. *Transact. R. As. Soc. 1*: 49-55.

MOORCROFT, W. & G. TREBECK (1841): Travels in the Himalayan Provinces of Hindustan and the Panjab from 1819 to 1825. Murray, London. Vols. 1+2, 525 + 530 pp.

OSBORN, H.F. (1912): Craniometry of the Equidae. *Memoirs Am. Mus. Nat. Hist., N.S. 1(3)*: 57-100.

POHLE, C. (1983): International Studbook of the Asiatic Wild Asses. Omnibus Vol. 9-13. Tierpark Berlin-Friedrichsfelde, Berlin. Pp. 136.

POHLE, C. (1986): International Studbook of the Asiatic Wild Asses. Omnibus Vol. 14-16. Tierpark Berlin-Friedrichsfelde, Berlin. Pp. 137-202.

RAJ, R.D. (1999): India: Wildlife main casualty on border with China. NY Transfer News Collective, Inter Press Service (www.blythe.org downloaded 18.Dec.2001).

SCHAEFER, E. (1950): Ueber den Himalaya ins Land der Goetter. Vieweg, Braunschweig. 215 pp.

SCHAEFER, E. (SIII): Documents SIII, Historische Bild- und Schriftgutsammlung. Zoological Museum Berlin (Humboldt University). ["Schaefer SIII" is a huge file of dated documents, over a period of several years, including correspondence, handwritten notes, etc.]

SCHALLER, G.B. (1998): Wildlife of the Tibetan Steppe. Chicago Univ. Press, Chicago. 373 pp.

SCHREIBER, A., V. EISENMANN & W. ZIMMERMANN (2000): Hemiones: Pluridisciplinary quest of their identities and relationships. Chapter 2: Pp. 34. *In*: EEP Asiatic equids husbandry guidelines (Ed.: Zimmermann, W.), Schueling Verlag, Muenster.

SHAH, N.V. (1994): Status survey of Southern Kiang (*Equus kiang polyodon*) in Sikkim. Report, Department of Zoology, Baroda University, India. 21 pp.

TRUMLER, E. (1959): Die Unterarten des Kiangs. *Saeugetierkundl. Mitt. 7*: 17-24.

TURNER, S. (1800): An account of an embassy to the court of the Teshoo Lama in Tibet. Nicol, London. 473 pp.

WADDELL, L.A. (1904): Map of Lhasa and its environs. *Geogr. J. 23*: 366 + map.

WADDELL, L.A. (1905): Lhasa and its mysteries. Murray, London. 530 pp.

WALTON, H.J. (1905): Notes on the natural history of southern Tibet. Pp. 419-432. *In*: The opening of Tibet (Ed.: Landon, P.). Doubleday, Page & Co., New York.

WANG, S. (1998): China red data book. Vol. 4. Science Press, Beijing. 417 pp.

WHITE, J.C. (1909): Sikhim and Bhutan. Arnold, London. 325 pp.

ZHANG, Y. (1997): Distribution of mammalian species in China. China Forestry Publ. House, Beijing. 280 pp.

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